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On a new method of recording the motions



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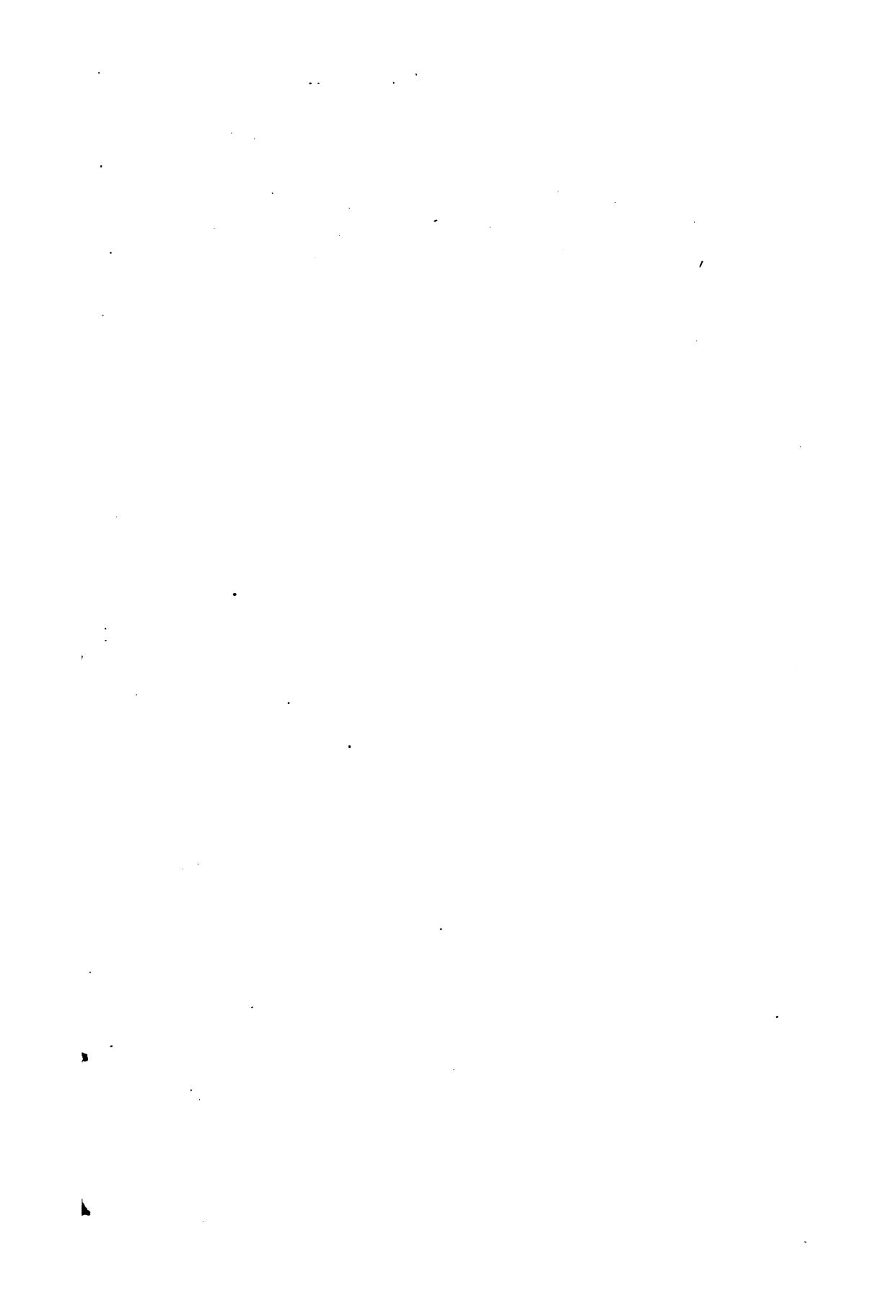
THE MOTIONS OF THE SOFT PALATE.

By

HARRISON ALLEN, M.D.

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THE MOTIONS OF THE SOFT PALATE.

BY

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PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF PENNSYLVANIA.

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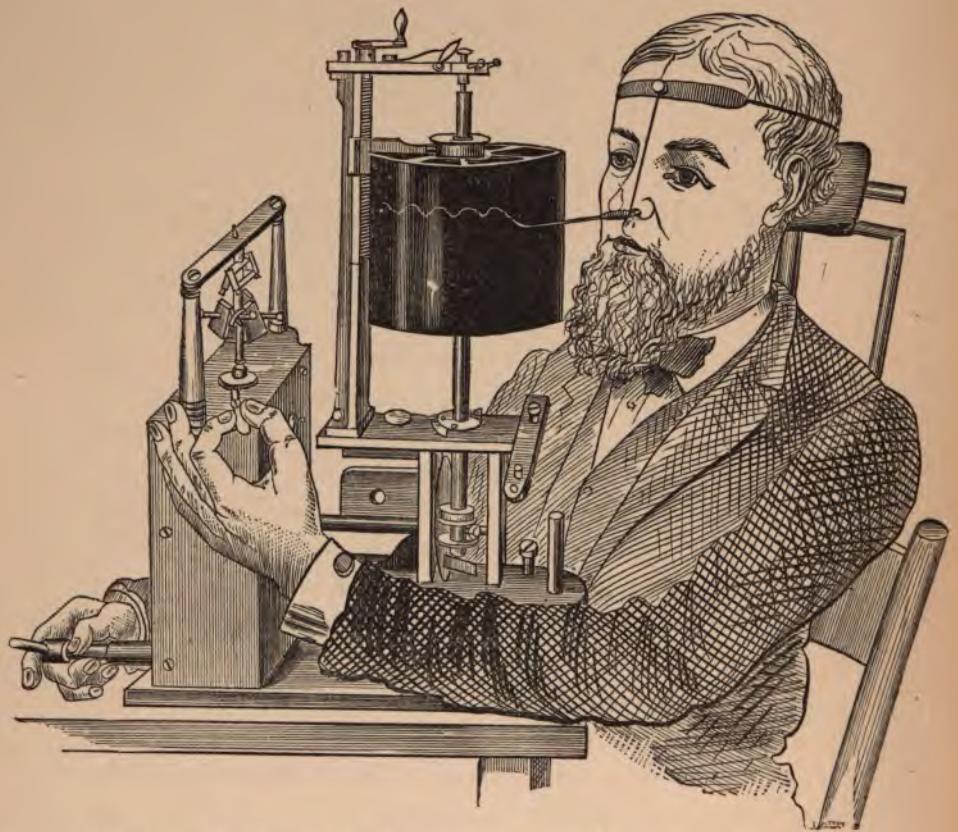
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The Palate-Myograph in position. The left hand of the operator determines the times at which the cylinder of the kymographion will revolve. The right hand is so placed that the clock-work of the kymographion can be wound up without interfering with an observation. The chair is brought well up to the table in order that the elbows may rest easily upon it.

ON  
A NEW METHOD  
OF RECORDING  
THE MOTIONS OF THE SOFT PALATE.

---

IN this paper I will describe a new method of recording the motions of the soft palate.

When a straight rod is passed through the nose from before backward in the living subject as far as is possible, it will be found to impinge against the roof of the naso-pharynx. In this position the rod is not influenced by any motions of the soft palate; but if the end of the rod which remains without the nostril be raised so that the rod be brought in contact with the anterior border of the nostril, the pharyngeal end of the rod will lie in a position which will cause a decided motion to be transmitted to it when the soft palate is raised. I have for a long time been in the habit of relying upon this test to determine when an instrument thrust through the nose had reached the region of the naso-pharynx.

Having observed that the sensations upon the fingers when the rod was thus held in position varied according to the character of the sound of the voice, I instituted a series of careful comparisons, which led me to infer that the elevation of the soft palate was

greater in the sounds of *ā* and *ē* than in the sounds of *i*, *ō*, and *ū*, or in any of the short vowel sounds. Substituting for the support of the fingers a flexible copper wire, one end of which was attached to the head-band, which is in common use for the support of the laryngeal mirror, and the wire itself bent round the rod so as to maintain the apposition of the rod against the anterior border of the nostril, I found that the motions of the palate caused a perceptible deviation of the free end of the rod. If, while the wire was thus supporting the rod, a rhinoscopic examination was made, the pharyngeal end of the rod was found projecting from the posterior nares into the naso-pharynx, at a point about midway between the roof and the upper surface of the relaxed soft palate. The rod being carefully adjusted so as to secure the best effects when the palate was raised, and the subject seated in front of the Ludwig kymographion (see Frontispiece), which had been previously prepared with carbon covered paper, it was ascertained that when the free end of the lever touched the cylinder, at a time when the latter was in motion from right to left and the soft palate was raised, that a distinct tracing appeared upon the cylinder and that the differences between the long and short sounds of the vowels were found to correlate with the curves made by the rod upon the kymographion.

Fig. 1 represents this rod as completed. *a* is that part of the rod, four inches in length, which is inserted within the nose. The end to the left being furnished with a bulb, and that to the right with a screw thread for attachment to *b*, which is a delicate piece of vul-

canite, marked by a number of annular depressions. The portion of the rod marked *c* extends from *b*, and represents that part of the instrument which is brought in contact with the kymographion-cylinder: it measures four inches in length, and terminates in a thin, flat, flexible end for the purpose of making a tracing.

FIG. 1.



FIG. 1.—The apparatus. The two arms of the rod should be of the same length. *a*, the arm, or portion of the lever which is inserted within the nose; *b*, the vulcanite annular support for the wire-loop; *c*, the arm or portion of the lever projecting from the nostril ( $\frac{2}{3}$ ).

When the instrument is in position (see Frontispiece) and the palate is raised (as in the voluntary motion which constitutes the first act of deglutition) a tracing is made (Fig. 2), which, when analyzed, is

FIG. 2.



FIG. 2.—Voluntary elevation of the soft palate illustrated in the first act of deglutition.

found to be composed of a number of acute depressions interrupting a horizontal line, and which yields for examination three distinct parts: first, a long, concave, slightly undulating line—which represents the extent of downward deviation of the rod from its horizontal position; second, a short vertical line,

which represents the descent of the palate, and begins at the point at which the curved line ends and terminates at the horizontal line; and, third, the horizontal line itself, which represents the record made by the end of the rod when at rest upon the surface of the moving cylinder. It is evident that the number of the notch-like depressions will answer to as many acts of elevation as are recorded at a single trial. The differences in the depressions will be the differences in the acts of elevation themselves. The degree of elevation and the abruptness of the fall are constant, but the length of the curve will depend upon the time taken by the palate to reach its highest elevation and the time it is sustained in that position before it falls to the position of rest.<sup>1</sup>

The tracing of the motion of the palate in the first act of deglutition is found to vary slightly from the above when the act of swallowing is completed (Fig. 3). This difference is expressed in the tracing

FIG. 3.



FIG. 3.—The tracing of the act of deglutition.

in a shorter curve of elevation, and a very gradual instead of a precipitous descent.

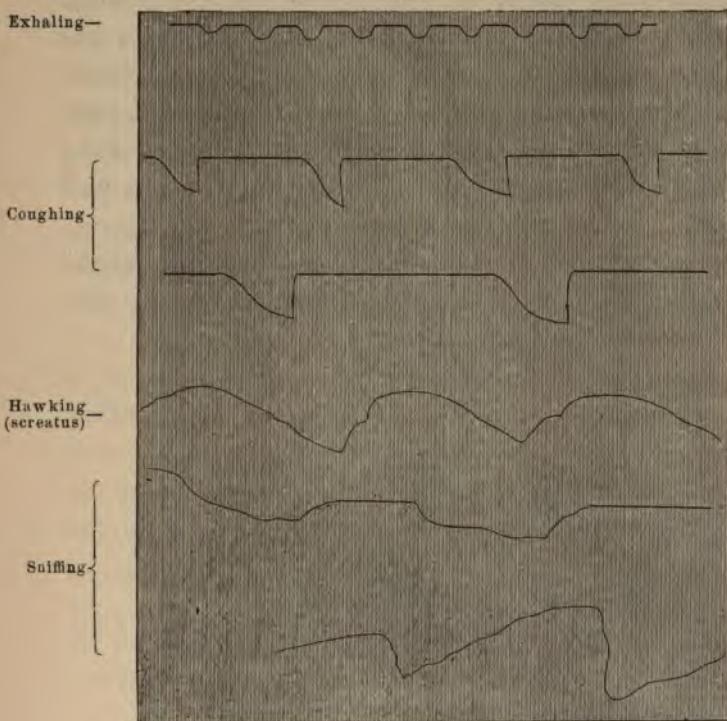
The tracings of the acts of "exhaling,"<sup>2</sup> of coughing, of hawking, and of sniffing will be found to be

<sup>1</sup> All tracings are to read from left to right.

<sup>2</sup> By "exhaling" is meant the sound without voice which is made by suddenly depressing the palate from a moderately elevated position (the mouth being closed), and by driving the air out through the nostrils. It is a sound habitual with some persons who suffer from catarrh.

sufficiently distinct by examination of the curves of Fig. 4.

FIG. 4.



The outlines, as a rule, are assumed to be due to the upper surface of the soft palate striking the end of the rod as it lies within the naso-pharynx. But it is well to remember that the rod may be pushed from right to left or from left to right in a *horizontal* direction by the contraction of the two levator palati muscles;<sup>1</sup> for the elevation of the palate is dependent upon

<sup>1</sup> The motions of the levator muscles can easily be seen by direct inspection from in front, as has been shown by Zaufal (see p. 172) and by Hilton (*ibid.*) from above.

the force exerted by these muscles, and if the rod be in the way of one of them it will be pushed to the median side and to a point nearer the centre of the naso-pharynx than it occupied prior to the time of contraction. If the rod be thrust through the right nostril it will be moved from left to right; if it be thrust through the left nostril it will be moved from right to left. These curves are best recorded by placing the kymographion-cylinder in a horizontal position.

The following cut exhibits a few of the lateral curves, so that an opportunity is afforded of contrasting them with the vertical curves.

FIG. 5.

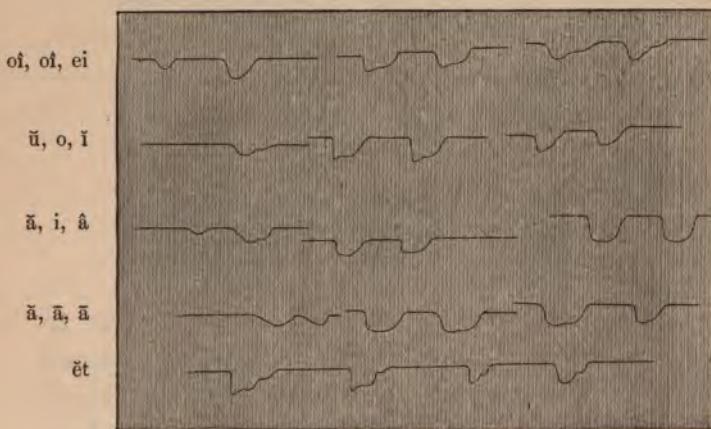


FIG. 5.—A number of palate movements recorded by the lever upon the horizontal cylinder of the kymographion.

The correlation between the two kinds of curves is sufficiently exact to permit either the one or the other to be used, and since it is convenient to retain the

cylinder in a vertical position the tracings will be assumed in this paper to be made with the upright cylinder unless it is otherwise stated.

In making the tracings in either of the positions the head must be carefully supported. A dentist's head-rest, such as is sold by the S. S. White Dental Manufacturing Company, answers an admirable purpose.<sup>1</sup> Should it at any time be found necessary to estimate the amount of variation in any curve due to the motion of the head, a piece of wire attached to the head-band may be made to touch the cylinder a short distance above the position of the index on the lever.<sup>2</sup>

Inasmuch as it is desirable to have a name by which the instrument can be designated I would propose for it the term *palate-myograph*. In an exact sense it furnishes the basis upon which the motions of the levator palati muscles (and through these structures the motions of the soft palate as well) can be recorded, and is hence a *myographion* of a particular pair of muscles whose general function is already known.

*Literature of the methods which have been proposed to record the motions of the soft palate and pharyngeal mechanisms generally.*—The motions of the soft palate have been studied in three ways: 1st, by direct observation; 2d, by the modification exerted by the

<sup>1</sup> I desire to return acknowledgments to Dr. Jas. W. White, President of the company, for assistance kindly rendered in carrying out the plan of these researches.

<sup>2</sup> I am indebted to my friend, Dr. N. A. Randolph, for this suggestion. In a few tracings, motions of the head are evident, see the tracing of sniffing and the first series of Fig. 5, and in Figs. 23, 37, and 43.

palate on the air of expiration; 3d, by the degrees of force exerted by the muscles themselves.

*Methods of Inspection.*—These include the observation of J. Hilton,<sup>1</sup> who, in a case of acquired defect of the face, due to the former presence of an osseous tumor, describes the “position of the palate during the formation of letters and words” as follows:—

“Complete utterance occurs only during expiration; and whilst repeating the alphabet the soft palate rises at the beginning and again descends at the termination of each letter or expiration; the sides of the pharynx also slightly approximate. The louder the voice, the more apparent are these actions in the palate and the pharynx. The extent of this adaptation in the ordinary voice resembles that which occurs in the mildest oral expiration; with this difference only that the palate is rather more steady in the process of articulation or formation of the letter than in simple expiration.

“The articulation of each of the vowels and the letter Y produces about the same extent of elevation of the palate. . . . In the formation of the letters H, M, and N, the soft palate is employed actively, and especially so in the letter M.”—Schuh<sup>2</sup> has recorded a somewhat similar case.—The motions of the salpingo-palatal fold, according to E. Zanfal,<sup>3</sup> are most pronounced in the letter *i* and in *e* (German), but less well marked in *o* and *u*, and weakest in *m* and *n*.—In progressive facial hemiatrophy Eulenberg found

<sup>1</sup> Guy's Hosp. Rep., i. 1836, 504.

<sup>2</sup> Wiener Med. Wochenschr., 1858; see Med. Times and Gaz. xix. 1859, 357.

<sup>3</sup> Archiv für Ohrenheilkunde, 1875, ix. 137.

the soft palate involved as well as the region termed by Grusset<sup>1</sup> (in quoting Eulenberg) "peri-laryngeal." The letter *r* together with other letters was pronounced with difficulty.—Duchenne<sup>2</sup> has studied the effects of electrical stimulation of the muscles of the palate.—Lennox Browne and Emil Behnke<sup>3</sup> have examined the shapes of the soft palate from the oral aspects, and have recorded their appearances by photography.

*Of the methods of recording* by the modification in the outgoing of air upon a flame or tambour, reference may be made to the researches of König and Hensen.<sup>4</sup>

A. Gentilli<sup>5</sup> has measured the force of the expired air which passed out of the nose in the formation of the sounds *m* and *n* by placing in front of the nostril a disk or fan upon which the expired air impinged. Accessories were attached thereto by means of which tracings were made upon a recording surface.

Among the methods dependent upon the degrees of force exerted by the palatal muscles may be mentioned that of Arloing and Carlet,<sup>6</sup> who placed in the mouth of a horse compressible flasks filled with

<sup>1</sup> *Traité Pratique des Maladies du Système Nerveux*, 1881, 627.

<sup>2</sup> Selections from Clinical Studies, Trans. in New Sydenham Soc., Series, 1883, 353.

<sup>3</sup> Voice, Song, and Speech, London, 1883, fig. 215.

<sup>4</sup> For general account and literature, see P. Grutzner in Hermann's *Handbuch der Physiologie*, I., Bd. II., Theil, 1879, 185–189. See, also, C. Blake, *Archives of Otology*, vii.

<sup>5</sup> The Glossograph; see abstract by C. Blake in *Amer. Journ. Otology*, iv. 1882, 193.

<sup>6</sup> *Comptes Rendus*, 1874 (Nov. 2).

water, which were in communication with a flexible tube, which in turn was united with a manometer.

It will be seen that no attempt appears to have been made to record the degrees of elevation of the palate. Marey<sup>1</sup> declares that any method of exploration of the palate by direct means by which the movements can be computed would be difficult, but makes no suggestion how the difficulties can be overcome.

I will now proceed to briefly analyze the tracings made by the palate-myograph in a variety of palate-motions in my own throat, in order to indicate the uses to which the method here proposed may be put. These descriptions will be placed under the following heads:—

Vowel-Curves.

Consonant-Curves.

Syllables ending in Vowels and those ending in Consonants contrasted.

Word-Curves.

Test-Phrases.

Variation.

The presumed Order of Development of the Palate-Curves.

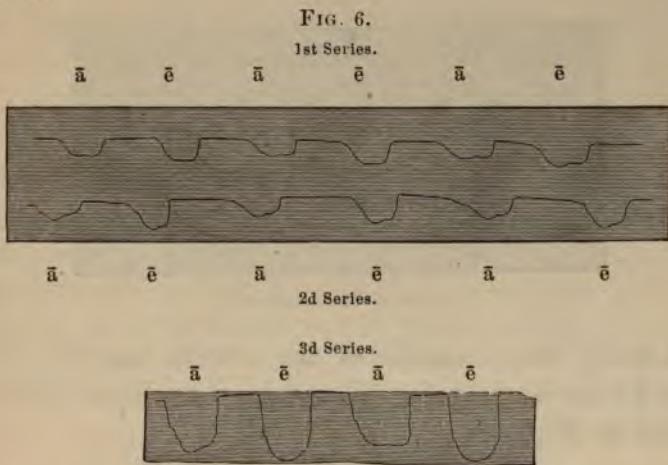
Inspiritæ.

Negations.

*The Vowel Curves.*—The lever is found to descend to the most pronounced degree in pronunciation of the

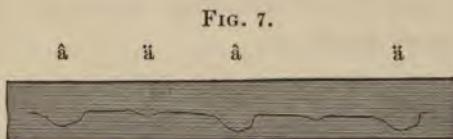
<sup>1</sup> “Autant il serait difficile d'explorer d'une manière directe les mouvements du voile du palais, autant il est facile de suivre ces mouvements d'après l'échappement d'air qui en est la conséquence.” La Méthode Graphique, etc., Paris, 1878, 396.

vowel ē. Next in order to ē may be ranged ā. In Fig. 6 a comparison between these two sounds is shown.



It will be seen that while a slight variation is detected between the curve of the same sound, when made a number of times in the same sitting, that the general character of each curve is distinct. In the third line the exaggerated character of the curve is to be ascribed to the rod having been thrust too far back.

So in Fig. 7, where ā (as in awe), and ä (as in father) are contrasted.



The ä-sound of *r* is difficult to render since the palate lies so far below the plane of the rod in making

this sound. These curves are found to be subject to considerable variation.

FIG. 8.

Variants of the sound of *r*.

Among other sounds of the vowels may be mentioned *ĕ* (as in "fern"), *ă* (as in "ask"). This is illustrated in (Fig. 9).

FIG. 9.

ĕ    ĕ    ĕ    ĕ    ĕ

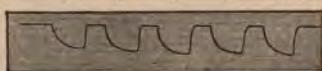


FIG. 10.

ắk    ắk              ă    ă    ă    ă



In Fig. 10 the first two tracings represent the entire word "ăk," and the remaining tracings the sound of *ă* in the same word.

In Fig. 11 the curves of the sounds of *ă* and *ĕ* are contrasted.

FIG. 11.

ă    ĕ    ă    ĕ



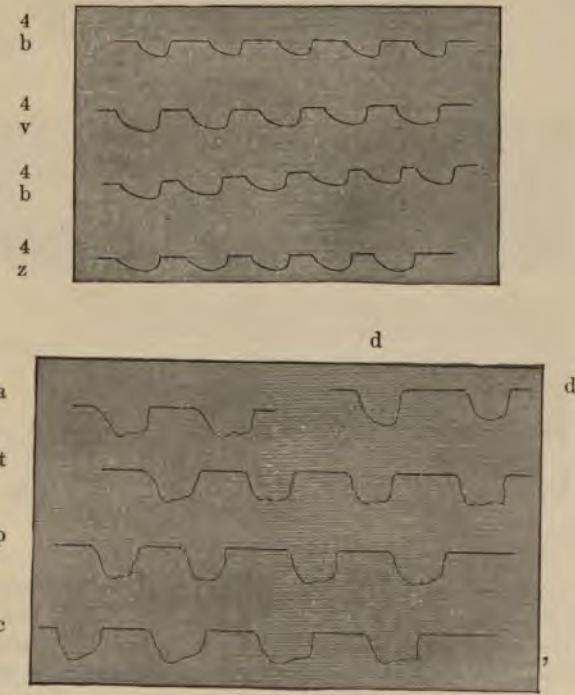
In Fig. 12 the curves of ū and ū and ū (as in *hot*), and ū and ū (as in *food*) are contrasted.

FIG. 12.



The *Consonant Curves*.—The tracings of the consonants will resemble those of the vowels more or less exactly according to the quality of the vowel sound entering into the consonant. Thus in Fig. 13 are

FIG. 13.



seen the value of the curve of  $b$ ,  $v$ , and  $z$ , based upon the curve of  $\bar{e}$  (Fig. 6).<sup>1</sup>

In Fig. 14 the curves of the consonants  $j$  and  $k$  based on  $\bar{a}$  are presented.

FIG. 14.

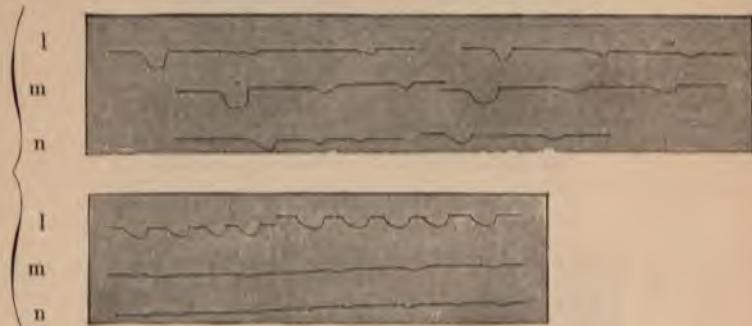


In Fig. 15 the curves of  $f$  and  $l$  are seen based upon  $\hat{e}$ .

FIG. 15.



FIG. 16.



In Fig. 16 a contrast of the letter  $\hat{e}$  in  $l$ ,  $m$ , and  $n$ <sup>2</sup> is given.

<sup>1</sup> The variations in the curves, and their limitations, are discussed on pages 185, 191.

<sup>2</sup> The results here recorded agree with those of Zaufal, but differ from those of Hilton see (p. 172), who found the motions of the palate especially marked

In Fig. 17 the curve of *e* in *s* is figured in a single group of variants.

FIG. 17.



In Fig. 18 the curve of the letter *ü* in the consonant *q* is figured.

FIG. 18.

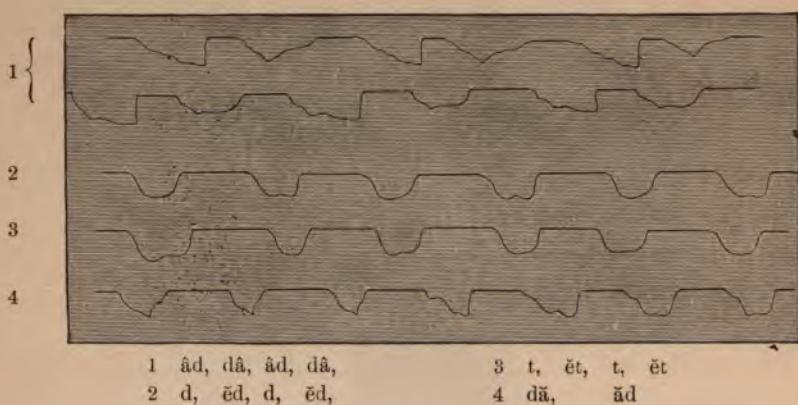


*The Syllables ending in Vowels and those ending in Consonants contrasted.*—Since words are purely of conventional character it is evident that the division of the curves into the phonetic values of vowels and consonants, and the arbitrary values assigned to the word-curve is one of convenience only. A series of curves is herewith presented (Fig. 19) which contrast the vowel sounds ending on consonants with the consonantal sounds ending on vowels. It is interesting to note that the mechanism of the palate is distinct in the two instances.

*The Word-curves.*—For practical purposes it is convenient to use the curves made by the pronunciation of entire words instead of the separate value of vowels

in the pronunciation of the letters *m* and *n*. It must be remembered that this observer looked down upon the palate. The palate would appear to move in the formation of the letters, but the palate is not sufficiently raised either to the degree sufficient to contract the levators or to raise the velum to a point at which a horizontal lever thrust into the naso-pharynx is raised.

FIG. 19.



or consonants. The analysis of these word-curves show that there are four kinds—the single, the double, the multiple, and the composite.

Of the *single word-curves* the following (Fig. 20) may be taken as examples.

Fig. 20.



Of the *double curves* the following (Fig. 21) may be taken as examples.

FIG. 21.

Sin, sins; tin, tins

Sins, sin; sins, sin



sins

Fig. 22 represents the curves belonging to the letter w, which, of course, has the value when pronounced of "double yū."

FIG. 22.

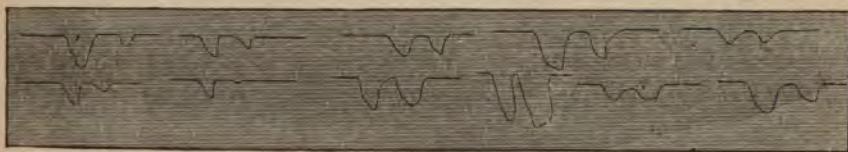


In Fig. 23 a *multiple word-curve* is seen in the word "kingdom." See, also, Fig. 24.

FIG. 23.

FIG. 24.<sup>1</sup>

not	snap	A once	A change
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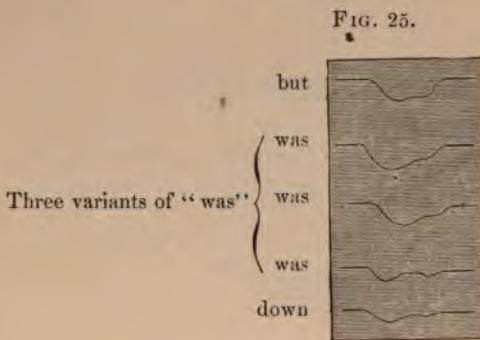


sneer	snarl	quinsy	quinsy	quinsy	kingdom.
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A series of double curves is represented in Fig. 24 showing the combination of curves more or less resembling one another. In each instance the palate comes to a state of rest for an appreciable interval before a second time descending. Three variants of "quinsy" are presented, for it was found to vary in Mr. Cohen and myself. The curves with the largest excursus was evidently influenced by the levator palati-muscle. The curves of "kingdom" are repeated in Fig. 23.

<sup>1</sup> The words marked "A" and "C" indicate the names of the recorders, Allen and Cohen.

A series of separate word-curves from the foregoing is represented in Fig. 25.



This group is intermediate between that of the single and the double curves. They all belong to words of a single syllable, yet are distinguished from those seen in Fig. 25 by showing but a slight disposition on the part of the palate to descend before it a second time ascends.

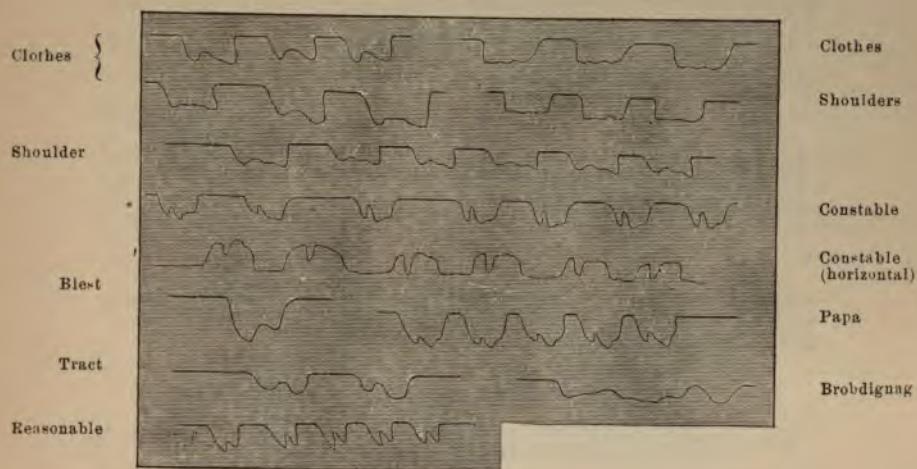
A second series of the same is seen in Fig. 26.



A third series, showing the greatest amount of secondary curving before the palate falls to rest, is seen in Fig. 27.

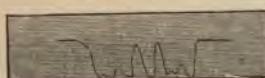
*Test-phrases.*—Since much of the interest which will obtain in the use of the instrument here described is clinical, it is likely that the curves described at the time of the utterance of a phrase will have the same value as those correlating to phonetic values or

FIG. 27.



to single words. A few phrases are herewith appended in illustration of this subject. (Figs. 28-33.) It is evident the palate has fewer difficulties to overcome during the pronunciation of the legend of Fig. 30 than that of any of the other legends. Fig. 33 is interesting in showing how exactly the curves of the words "to" and "be" repeat themselves in the deliberately pronounced phrase "to be or not to be."

FIG. 28.



An empty bag cannot stand upright.

FIG. 29.



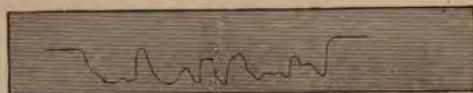
Honesty is the best policy.

FIG. 30.



A bird in the hand is worth two in the bush.

FIG. 31.



Early to bed, early  
to rise makes a man  
healthy, wealthy, and  
wise.

FIG. 32.



A rolling stone gathers no moss.

FIG. 33.



to      be      or      not      to      be

To be or not to be.

The question that has often been asked why words are pronounced in a manner different from that which would be premised from the spelling, and why the street pedlers of cast-off clothing persist in crying "old clo'" when "old clothes" is known by them to be the correct pronunciation, may receive an answer when the curves of the word as really pronounced are compared to the curves of the word as they should be pronounced if every syllable were given its full value. Such words as Magdalen, Ispahan, Treheran, and Beauchamp may serve as examples. Fig. 34

FIG. 34.



Beecham (repeated.)

Beauchamp.

illustrates the difference between Beauchamp and "Beecham."

*Variation.*—It is not to be supposed, however, that the palate will make the same curves for the same sounds in all individuals. A margin for individual variation must be made if any conclusion can be drawn from the manner in which my assistant, Mr. Cohen, will form certain curves as contrasted to those of other observers, including myself.

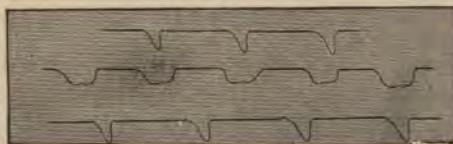
Thus Mr. Cohen in pronouncing “*and*” secures two curves (see Fig. 35), whereas in my own throat but a single curve of a different shape results.<sup>1</sup>

FIG. 35.

Variations in “*and*” in two individuals.

The character of the curve is here of less importance than the number, for in a separate series of studies of “*and*” in my own throat (see Fig. 36) I have

FIG. 36.

Variations in “*and*” in the same individual.

secured two distinct types of curves from this word but never more than one curve for each word. The difference in the shapes of the curves may be attributed to the difference in the position of the rod with respect to the palate during the different sittings.

<sup>1</sup> The first two of the first series of lines have unfortunately been mutilated in Fig. 35. The last two (placed to the right of the cut) are intact.

*The presumed Order of Development of the Palate-Curves.*—The palate-myograph may prove useful, it is thought, in studying the times at which the different motions of the palate in phonation came into play. If the articulate sounds made by a child be imitated when the palate-myograph is in position it will be seen that the sound of mamma is the simplest of them all. I have under this heading simply contrasted the curves of “mámmá” and “pápá” (see Fig. 27), to show that it is probable that the reason for the sound “mámmá” (Fig. 37) being first used by the infant is that the palate is moved least in producing the sound.

FIG. 37.



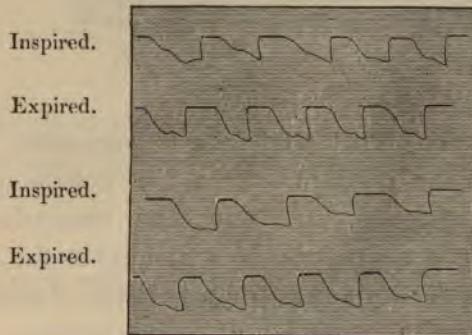
The curves of “mamma.”

*The Inspiriæ.*—Since the sounds of speech for the most part are made upon the out-going breath the movements of the soft palate in assisting in their formation will be co-related to the respiratory act. The palatal mechanism might be compared to a second sphincter placed between the laryngeal sphincter and the lips. When the proposition is differently stated and the speech sounds are known to be found not on the out-going but on the in-going air, it has been thought worth while to notice if the palatal mechanism is in any way modified on account of the air passing through the pharynx. No sound of the character just named is normal to English or indeed to any of the European languages. Dr. D. G. Brinton, who first called my attention to the subject, informs me that in

the Bushman dialect as many as four of the inspiritæ (as they are termed) can be enumerated. The Esquimaux have at least one, the "cluck," and the Arabians some.

In experimenting with the inspiritæ difficulty was experienced in the unpleasant drying of the vocal cord attending the act of articulating upon the in-going breath. I have contented myself to reproduce the "cluck" sound (Fig. 38) both on inspiration

FIG. 38.



The curves of "cluck."

and on expiration in order that the two can be contrasted; it will be noticed that the difference between the two sets of curves is very slight if any can be said to exist.

FIG. 39.



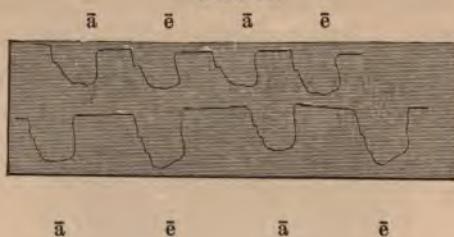
In Fig. 39 the curves of the vowel sounds  $\bar{o}$ ,  $\bar{e}$ ,  $\bar{i}$ ,  $\bar{\bar{o}}$ ,  $\bar{\bar{u}}$  are represented as formed in inspiration.<sup>1</sup>

<sup>1</sup> Dr. Berens.

The inspiritæ of low pitch cause larger curves to be described than those of high pitch.

The amount of elevation of the soft palate in enunciation is independent or nearly so both of volume and of pitch. In Fig. 40 the vowels  $\bar{a}$  and  $\bar{e}$  are

FIG. 40.

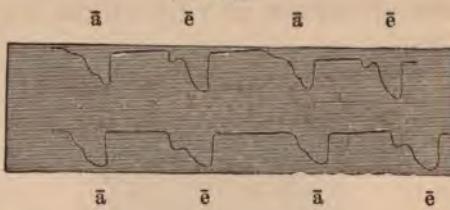


$\bar{a}$        $\bar{e}$        $\bar{a}$        $\bar{e}$

contrasted in the head and chest registers. The curves show some influence from the action of the levator palati muscles, but, with the exception of being a little too deep, are normal curves for these sounds. It will be seen that there is little or no effect of register upon the formation of these curves.

In two series the following falsetto notes (Fig. 41) were formed on the same vowel sounds. A more

FIG. 41.



$\bar{a}$        $\bar{e}$        $\bar{a}$        $\bar{e}$

marked difference is here observed between the curves. The palate appears to be tremulous, and makes two undulations in the curves of  $\bar{e}$ . This record is from

my own throat. I have no vocal training, and it is probable that the palate of a vocalist may give different results.

*Negations.*—While it has been seen that the palate moves in every consonantal and vowel sound, it nevertheless does not assist in the formation of many sounds. Thus the motions of the palate are the same in the word “*souf*” as in “*south*” (Fig. 42), and

FIG. 42.

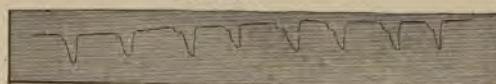
“*Souf*” and *south*.



in “*nuffing*” as in “*nothing*” (Fig. 43). The difficulty the negro acknowledges in pronouncing

FIG. 43.

“*Nuffing*” and *nothing*.



“*south*” and “*nothing*” (converting the words into “*souf*” and “*nuffing*”) lies in the relations of the tip of the tongue to the teeth, hard palate, and lips (in a word to his prognathism) and not to any peculiarities of the soft palate.

In like manner those persons who pronounce *what* as though spelt “*vat*” (Fig. 44) make precisely the

FIG. 44.

Whât

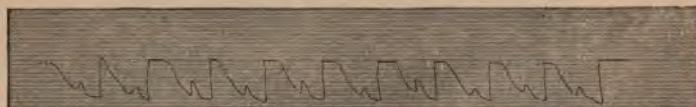
“Vât.”



same palate curves for the two sounds. The curves, indeed, are those of *a* with the terminal consonant *t*, and the distinction between the *wh* and the *v* are in the lips and teeth.

The distinctions between *that* and “*lat*” (Fig. 45) are of the same character. Most children are slow in

FIG. 45.  
Lăt and thăt.



procuring the “*th*” sound but acquire the “*l*” sound easily. The same remark applies to the Chinese.

The same comments are not applicable to the distinction between *well* and “*vell*” (Fig. 46); for a

FIG. 46.  
Wĕll and “vĕll.”



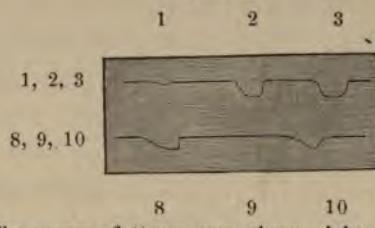
simple curve is seen to be recorded for “*well*,” but a sinuate curve for “*vell*.”

In Fig. 47 the curve of the words *one, two, three, eight, nine, ten* are recorded with the object of showing that the word “*one*” makes scarcely any curve, the word “*nine*” none.

**REMARKS.**—Such in brief is an outline of this new method. The fact that the soft palate is raised in articulation of all articulate sounds, that it is raised in the acts of swallowing, of coughing, of hawking,

can be readily demonstrated. The length of time at which the palate remains elevated, and the duration of the time of ascent and descent, can also be easily

FIG. 47



The curves of "one, two, three, eight, nine, ten."

ascertained. The palate is seen to be raised once only for some words; twice for others, and three times for others. The numbers of these motions are invariable within a narrow range of individual variation. The size of the curves, however, is not fixed owing to the difficulty of always reaching precisely the same spot of the broad upper surface of the soft palate. But the curves, whether deep or shallow, hold the same proportions one to another, as is seen in the different series of Fig. 6, and in the various curves of the letter *l* in Fig. 16, and of the letter *s* in Fig. 17. By proper care in freeing the rod from contact with the salpingo-palatal fold, and in placing the rod about the centre of the palate, the exaggeration of curve can be in great measure prevented. It is evident that variation in the size of the bulb at the pharyngeal end of the rod will cause corresponding variations in the size of the curves. Hence it is recommended to preserve the form and size of the bulb described on p. 167, and to keep it free from mucus.

Even if the same spot could at all times be reached, would it be reasonable to expect the curves to have

uniform values for the same sound in different individuals, or in the same individual at different times, or even in the same individual at different times in a single sitting? The soft palate is but partially under the control of the will, and this control varies in different persons. The palate, as other muscular structures, is subject to fatigue, or may act irregularly from prolonged contact with the metallic rod. Again, the personal element that enters into the variation in the transit of volitional impulses must be as appreciable in the case of the soft palate as any other muscular apparatus in the economy.

On the whole, it may be said that the sources of inconstancy of the curves are not sufficient to invalidate the claim of accuracy for the method.

The palate-myograph may be of use in studying the mechanism of the soft palate, in disease as well as in health. It is evident that in paralysis of the palate the motions would be absent, and that by this method a means of detection of this condition is available. It may probably prove of use in studying stammering, and in determining the degree of degeneration of the levator-palati muscles in progressive dry aural catarrh.

As the soft palate ascends, the oral surface becomes concave.<sup>1</sup> This concavity is occupied by the convex

<sup>1</sup> It would be an ungracious act to examine critically the figures in the numerous works upon the throat and mouth in which the palate is represented, as seen in sagittal (anterio-posterior) section during the formation of the vowels and consonants; without exception they are based upon erroneous conceptions of the movements of the velum in speech.

dorsum of the tongue in some sounds as in the consonant quantities, *kā* and *qu*, etc., but may be free from the tongue in other sounds, as that of *o*. The elevation of the palate is not the result of the pushing up of the relaxed velum by the lingual basi-dorsum, but of the active elevation by means of its own muscles. The correlations of the tongue with the palate are, as a rule, notwithstanding, exact enough to warrant careful comparison of the two factors in the mechanism of speech.

The palate-myograph may be employed in the study of phonetics, together with the different forms of glossographs as an accessory, if the premises of the preceding paragraph are correct.

On the action of palato-pharyngeal and azygos muscles little can be here said. I have made a number of observations with a long curved rod passed through the nose, and have ascertained that the approximation of the two palato-pharyngei may be recorded, but the retention of the rod in this position is painful, excites a little bleeding, and soon throws the pharynx into an excited state.

The plan of holding the rod in any desired position by the flexible wire and head band, can be utilized in keeping instruments in position such as the snare, the syringe, etc., so that the head-band may be employed as an accessory in the removal of growths from the naso-pharynx and the nose.<sup>1</sup>

<sup>1</sup> I desire to express my acknowledgments to Dr. N. A. Randolph, Dr. C. Berens, and Mr. N. Cohen, for assistance rendered during the course of the investigation.

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The foregoing account is designed to indicate the medical uses of this method of studying palatal motions. The method may have a wider range of application than the one delineated; and it may be well to suggest at this place that, in the judgment of competent critics, it may be made available for the comparative study of language, for the instruction of the deaf, and for the formation of a system of logography or short-hand writing.

I have thought it best, however, to confine my text to the limits which naturally define the horizon of medical observation, rather than delay publication by awaiting the results of laborious efforts needed to extend these limits over a wider and untried field.

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